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INVESTIGATING THE INTEGRATION OF ACQUIRED FIRMS IN HIGH-TECHNOLOGY INDUSTRIES: *IMPLICATIONS FOR INDUSTRIAL POLICY*

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Acquisition activity persists despite evidence that acquisitions do not improve firm performance. Further, government policy toward the defense industry has advocated consolidation in the name of nominal cost savings. We explore the role acquisitions play toward technology transfer and begin to identify factors associated with acquisition success through a review of existing research on post-acquisition performance that primarily considers acquiring firm stock performance. Using this research as a foundation, we build a model to analyze post-acquisition performance using a sample of high-technology firms. Results suggest critical success factors associated with post-acquisition stock performance are poorly understood. We conclude that proactive government policy toward high-technology industry mergers and acquisitions may be misguided due to difficulty in predicting acquisition outcomes.

Merger and acquisition activity involves discrete events associated with a high tempo of change that modify the competitive dynamics of affected industries. Merged firms combine additional resources and capacity that can threaten the market position and profitability of remaining firms. The implications of using acquisitions to alter competition

in industry may carry higher stakes in high-technology industries, because high-technology firms are an important source of U.S. economic competitiveness and are key components of the defense industrial base.

The Department of Defense (DoD) encouraged merger and acquisition (M&A) activity after then Deputy Sec-

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retary of Defense William Perry told defense industry executives that declining defense spending required consolidation. The 1993 meeting became known as the "Last Supper" and in the

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expected cost savings, reimbursed defense firms for the cost of merging. The program, to date, has resulted in \$4.77 billion in DoD savings with a corresponding cost of \$869 million (Department of Defense [DoD], 2002), or approximately one percent of the 2003 defense budget.

Firms pursue acquisitions to increase performance (Finkelstein, 1997); however, research findings on the impact of an acquisition on acquiring firm performance remains inconclusive (e.g., Haspeslagh & Jemison, 1991; Sirower, 1997). Given the high level and dollar of acquisition activity, research needs to identify factors associated with acquisition success. The goal of the current paper is to begin to answer the following policy questions:

1. Does technology transfer occur when high-technology firms are acquired?
2. Is it reasonable to anticipate investor benefits from defense industry consolidation?

next four years the value of defense mergers was eight times the level of the preceding four years (Augustine, 1997). In a controversial program that became to be known as *payoffs for layoffs*, the DoD, in an effort to help realize

TECHNOLOGY AS A MOTIVATION FOR ACQUISITIONS

Acquiring technology is often the motivation for acquiring another firm. In reviewing the different perspectives toward acquiring technology, two conflicting perspectives dominate. Researchers tend to either view external technology as a substitute for Barkema and Vermeulen (1998) Bower (2001) or a complement to Cohen and Levinthal (1989, 1990) internal innovation. Either view has implications for technology transfer.

In the current sample¹, the average research and development (R&D) intensity for acquiring firms was significantly below the average for firms in their industry ($p < .001$), suggesting that firms use acquisitions as a substitute for R&D or that acquired technology is used as a substitute for internal innovation.

However, acquirers still perform R&D and it may provide a facilitating role to acquiring external technology. This idea relates to the concept of *absorptive capacity*, or the ability of a firm to recognize, assimilate, and convert new information to commercial ends, that is built up through R&D investment (Cohen & Levinthal, 1989, 1990). If firms acquire high-technology firms for the express purpose of assimilating a target firm's technology, there are clear implications for the acquisition of U.S. companies by foreign firms.

For example, *ASM Lithography Holding NV*, a Dutch company, and its May 2001 acquisition of *Silicon Valley Group* (SVG) Inc. was delayed, because of national-security issues with a SVG subsidiary, *Tinsley*, which makes lens polishing technology for chip equipment, satellites, and missile

guidance systems (Clark & Simpson, 2001). However, the acquisition was later approved and completed in May 2001 with the caveat ASM Lithography try to divest Tinsley over a six month period (Simpson, 2001).²

Without national security issues the acquisition of SVG would have been approved, because the Exxon-Florio foreign acquisition law does not allow for consideration of economic issues (Simpson, 2001). Foreign firms accounted for approximately five percent of the acquisitions of U.S. high-technology firms between 1994 and 1997, and this may be an area for expanding anti-trust policy. The impact of the technology transferred on U.S. economic competitiveness is unknown, and represents an opportunity for additional research.

FACTORS COMMONLY ASSOCIATED WITH ACQUISITION SUCCESS

Similar to previous studies, the current sample of acquisitions, on average, did not lead to abnormal returns for acquiring firms. However, some acquisitions performed better than others, so what factors are associated with acquisition success? A literature review of 46 empirical studies of post-acquisition performance published since Jensen and Ruback's (1983) review identified little overlap in the studies that researchers considered important in explaining post-acquisition performance.³ We include the most commonly studied variables in our analysis to avoid statistical artifacts from missing variables. The logic behind the most commonly studied variables, the generally anticipated impact of each variable on post-acquisition performance, and their

significance in the current study are shown in Table 1. The following sections further discuss this material.

DIVERSIFICATION

The impact of firm diversification on subsequent performance has received the most attention of researchers with some measure of relatedness considered in 30 of the 46 studies. Diversification involves whether a firm acquires another firm in its same industry, a related acquisition, or a firm in a different industry. Although no relationship between acquiring a related versus an unrelated firm and post-acquisition performance has been found in some studies (e.g., Fowler & Schmidt, 1989), the preponderance of literature suggests acquiring related firms leads to increased post-acquisition performance (e.g., Kusewitt, 1985).

Current results are consistent with existing research in that the acquisition of related targets leads to higher post-acquisition performance ($p < .05$; one-tail). However, the observed relationship is relatively weak with the degree that a target firm relates to an acquirer only explaining 2.1 percent of subsequent stock market performance. Still, the results support viewing technological progress as largely path dependent with the implication that acquiring firms are more likely to search and find value in target firms in areas related to their existing technological capabilities. The possibility of increased performance may depend on a firm staying in a related industry.

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Table 1. Common Post-Acquisition Performance Research Variables

Variable	Anticipated Impact on Performance	Current Findings ^a
Diversification	Diversification (e.g., acquiring firms in non-related industries) is expected to have a negative impact on performance (see Berger & Ofek, 1995).	Expected impact is supported ($p < .05$) and explains 2.1% of the variance in performance.
Relative Size of Firms	The acquisition of smaller firms, in comparison to the acquiring firm, is expected to be easier and result in higher performance (see Kusewitt, 1985).	Expected impact is supported ($p < .01$) and explains 7.2% of the variance in performance.
Acquisition Experience	Acquisition experience is generally considered to positively impact performance (see Hitt, Harrison, & Ireland, 2001).	Expected impact is not supported ($p = .22$).
Method of Accounting	Purchase accounting is generally considered to have a positive impact on performance (see Ravenscraft & Scherer, 1987).	Expected impact is not supported ($p = .15$).
R&D Expenditures	R&D expenditures should improve post-acquisition performance (see Cohen & Levinthal, 1989, 1990).	Expected impact is not supported ($p = .41$).
Friendliness of Acquisition	Friendly acquisitions are expected to lead to higher performance (see Kusewitt, 1985).	Not examined due to an insufficient occurrence of hostile high-technology acquisitions.
Debt Level	Firms with lower debt levels are more likely to experience higher performance (see Haspeslagh & Jemison, 1991).	Expected impact is supported ($p < .05$), and explains 3.0% of the variance in performance.
Form of Acquisition	Tender offers, in contrast to mergers, lead to higher performance (see Berkovitch & Khanna, 1991).	Expected impact is supported ($p < .10$), and explains 1.8% of the variance in performance.
Target Firm Performance	There are conflicting perspectives on how target firm performance will impact an acquiring firm's post-acquisition performance. Researchers support viewing post-acquisition performance as independent of target firm performance (Anand & Singh, 1997), distressed targets leading to higher performance (Bruton, Oviatt, & White, 1994), or profitable targets leading to higher performance (Mahoney & Pandian, 1992).	Current results suggest that acquiring firm profitability is not related to post-acquisition performance ($p = .15$).

^a One-tail tests of significance.

In contrast to this finding, defense firms that are prime contractors have tended to make acquisitions that both consolidate specific industries (e.g., aircraft and Lockheed's purchase of General Dynamic's aerospace unit) as well as across industries (e.g., aircraft and ships with Northrop Grumman's purchase of Newport News Shipbuilding). However, defense firms appear to have generally chosen to focus on acquiring other firms in defense industry and not expanding into commercial markets. It is possible that the specialization of defense firms in relating to their unique customer, the government, provides them an advantage that does not correspond to traditional industry boundaries.

RELATIVE SIZE OF FIRMS

The ability of an acquiring firm to assimilate a target firm may be impacted by their relative size simply because it is easier for a larger firm to integrate resources from a smaller firm. Kitching (1967) found that unsuccessful acquisitions correlated strongly between firms of similar size. Acquisition risk may be reduced if the target firm is large enough to achieve 'critical mass' while remaining smaller than the acquiring firm (Kusewitt, 1985), due to decreased financial strain and integrative effort. Existing research suggests that, in general, acquisitions of smaller firms by larger firms should lead to higher performance.

Current results indicate that larger targets correlate with higher stock gains ($p < .01$; one tail) and explain 7.2 percent of the observed variance in post-acquisition performance. However, over 98 percent of the targets were still smaller than the acquiring firm. This result appears

to confirm previous research that acquisition risk is reduced when a target is smaller than an acquiring firm, but large enough to demand enough management attention to ensure proper integration. For acquisitions involving large, prime defense contractors, targets from this point forward will most likely be smaller than the prime defense contractors. This suggests a potential post-acquisition performance advantage for prime contractors in the defense industry.

ACQUISITION EXPERIENCE

Experience from past acquisitions, at the organizational level, may build facilitating processes for the identification and integration of target firm resources that may be required to improve post-acquisition performance (Haspeslagh & Jemison, 1991). However, consistent findings on the

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relationship between acquisition experience and post-acquisition performance do not exist. Still, Hitt, Harrison, and Ireland (2001) caution "the importance of the link between managerial experience and M&A success should not be underestimated (p. 55)." Current results suggest that either high-technology acquisitions are unique with acquisition experience not predicting post-acquisition performance ($p = .22$; one tail). Alternatively, this result may imply that firms *could* benefit from acquisition experience, and that managers simply treat acquisitions as unique events.

METHOD OF ACCOUNTING

Few studies control for accounting method, even though it has been shown to impact firm performance measures (Ravenscraft & Scherer, 1987). Historically, there have been two methods of accounting for an acquisition — pooling of interests or purchase.⁴ Under pooling of interests, assets of an acquired firm are recorded at their pre-merger book value and the difference in amount paid

"Friendly acquisitions involve transactions where an acquiring firm's overtures are not resisted by a target firm's top management."

for a firm is either debited or credited to acquirer's stockholders equity account. Under purchase accounting, acquired assets are entered at the effective price paid. Pooling of interest accounting is significantly associated with higher acquisition premiums (Ravenscraft & Scherer, 1987) and the premium paid negatively impacts post-acquisition performance (Sirower, 1997). Current results suggest that method of accounting does not impact post-acquisition performance ($p = .15$; one-tail).

R&D EXPENDITURE

Research suggests that increased technological capability enables firms to be aware of the significance of new external technology (Berry & Taggart, 1998). Nelson and Winter (1978) argue that the capacity to recognize and exploit technological opportunities is a function of a firm's technology resource commitments, such as R&D investments, and that firms that track the progress of technology tend to prosper. R&D investments build

internal technological capabilities that help firms adapt to changing markets (Zahra & Covin, 1993). Additionally, more R&D intensive firms should be more proactive in exploiting external opportunities (Cohen & Levinthal, 1990). However, current results suggest that there may be diminishing returns to performing R&D beyond some threshold level. In other words, firms may only need to perform enough R&D to remain aware of external technology and maintain the ability to absorb needed technological developments.

FRIENDLINESS OF ACQUISITIONS

Friendly acquisitions involve transactions where an acquiring firm's overtures are not resisted by a target firm's top management. Theory suggests friendly acquisition should lead to higher performance. For example, Kusewitt (1985) simply stated: "unfriendly takeovers should be avoided (p. 166)." Consequently, hostile acquisitions are relatively infrequent with only 172 hostile acquisitions out of over 35,000 completed between 1976 and 1990 (Jensen, 1993). Therefore, whether an acquisition was friendly is not included in the current analysis, due to a lack of observed hostile acquisitions.

DEBT LEVEL

The debt of an acquiring firm may impact post-acquisition performance. Unused debt capacity can be regarded as a firm resource (Haspeslagh & Jemison, 1991), and if an acquiring firm cannot afford the price demanded by a target, the anticipated synergies in a combined company cannot be achieved. Additionally, higher debt levels may lead to more strict financial controls that can decrease

performance (Hitt, Hoskisson, Johnson, & Moesel, 1996). Present results suggest that firms with less debt experience higher subsequent performance ($p < .05$; one tail) with debt explaining three percent of the variance in an acquiring firm's post-acquisition performance. It appears that increased debt levels represent an additional burden for acquiring firms seeking increased performance. This represents a challenge for most defense firms since they carry relatively large levels of debt and poor credit ratings (Defense Science Board, 2000).

FORM OF ACQUISITION

The *form of an acquisition* involves the nature of the offer made by an acquiring firm with the primary choices involving either a tender offer or a merger (Berkovitch & Khanna, 1991). *Tender offers*, or proposals made directly to a target firm's shareholders, are made through public bids, while *mergers*, or negotiations directly with a target firm's managers, are generally initiated under a veil of secrecy. Existing research has found that tender offers significantly outperform mergers (Rau & Vermeulen, 1998). Berkovitch and Khanna (1991) propose that the difference in performance results from differences in the amount of information made public during a tender offer versus a merger, where the greater information disclosure in tender offers leads increased synergy. The basis of Berkovitch and Khanna's (1991) argument is that tender offers lead to greater competition for a target firm. However, an alternate explanation relevant to the acquisition of technology resources is that the increased information disclosure

of tender offers decreases the amount of uncertainty target firm employees' experience.

Acquisitions create uncertainty for employees in target firms leading to a tendency toward self-preservation that inhibits transfer of capabilities and resources (Haspeslagh & Jemison, 1991). Employee resistance to integration is particularly relevant in the assimilation of the technology resources because the implicit expertise of R&D personnel is far more valuable than the technology they have developed (Bower, 2001).

Whatever the ultimate reason, acquisitions completed through a tender offer are expected to be positively related to post-acquisition performance. Current results suggest that tender offers do lead to higher post-acquisition performance ($p < .10$; one tail) with form of acquisition explaining 1.8 percent of the variance in post-acquisition performance. This result supports either tender offers resulting in increased competition or information disclosure leads to increased post-acquisition performance.

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TARGET FIRM PERFORMANCE

It seems reasonable that would-be acquirers will evaluate the attractiveness of a target firm's resources in light of the firm's performance. However, consistent guidance on the expected relationship does not exist. There are at least three possible relationships between target firm performance and an acquiring firm's post-acquisition performance.

First, acquiring firm's may view target firm profitability as a signal of the value attached to its technological resources by would-be acquirers. Specifically, it is possible that would-be acquirers will interpret positive profitability as the market's independent verification that the target firm possesses valuable resources. High profits signal uncertain imitability and the more firm specific or rare a firm's resources, the more likely the firm will earn above normal rates of return (Mahoney & Pandian, 1992). Therefore, higher post-acquisition performance may result from acquiring target firms that possess valuable resource combinations indicated by higher profitability.

The second possibility is that, consistent with Bruton, Oviatt, and White's (1994) observations, acquirers are particu-

the benefit of transferring firm resources in an acquisition is independent of the acquired firm's prior performance. Therefore, in their opinion, acquiring firms should seek targets with resources they need without considering the profitability of the firms employing those resources. Current results indicate that target firm profitability in the year prior to an acquisition is not related to post-acquisition performance by an acquiring firm ($p = .15$; one tail). This implies that acquiring firms consider both distressed and highly profitable firms as potential acquisition candidates.

IMPACT OF EXTERNAL FORCES ON ACQUISITION PERFORMANCE

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mentary resources needed to create competitive advantage. Thus, the acquisition of a poorly performing firm may be attractive if the acquiring firm assumes it can improve the management of the target firm's resources or successfully combine them with its own, pre-existing internal resources.

Third, it may be that target firm profitability has no impact on an acquiring firm's post-acquisition performance. Anand and Singh (1997) suggest that

larly attracted to distressed firms with resources of known or potential value to the acquirer. The assumption here is that the target firm's poor financial performance is a reflection of either resource mismanagement or the absence of comple-

The vast majority of acquisition research and the variables discussed so far only consider the impact of variables linked to factors internal to firms that can be directly observed and to some extent controlled. However, it is also reasonable that post-acquisition performance depends on factors external to firms.

We consider two characteristics that may influence post-acquisition performance. First, an acquiring firm's environment is important because it sets the competitive context, and rivalry over scarce environmental resources and opportunities should influence firm actions and subsequent performance. Industry characteristics can influence the performance of firms (Porter, 1985). Further, Bergh (1998) found the benefits of external technology were moderated by a firm's environment. Second, the timing of an acquisition may impact an acquiring firm's post-acquisition performance.

Table 2. External Forces Influencing Post-Acquisition Performance

Variable	Anticipated Impact on Performance	Current Findings ^a
Firm Environment	<p>Firms operating in more attractive environments should experience higher performance (see Dess & Beard, 1984).</p> <ol style="list-style-type: none"> 1. Acquiring firms operating in munificent environments are more likely to experience higher performance. 2. Acquiring firms operating in less dynamic environments are more likely to experience higher performance. 3. Acquiring firms operating in less complex environments are more likely to experience higher performance. 	<ol style="list-style-type: none"> 1. Munificence does not impact post-acquisition performance ($p = .28$). 2. Dynamism does not impact post-acquisition performance ($p = .42$). 3. Complexity is significant ($p < .05$) and explains 2.4 % of post-acquisition performance.
Timing of Acquisition	Early acquisitions should outperform later acquisitions.	Mixed support, but the year an acquisition was completed explained 4.7 % of post-acquisition performance.
^a One-tail tests of significance		

The impact of variables related to both external factors on subsequent post-acquisition performance is summarized in Table 2. The following sections further discuss these relationships.

FIRM ENVIRONMENT

Research supports viewing a firm's environment as a multidimensional construct with three dimensions — munificence, dynamism, and complexity (e.g., Dess & Beard, 1984). Although the labels applied to the different dimensions vary, there is an underlying commonality in the underlying concepts. For the

purposes of the present research, the effects of industry are controlled by computing firm measures relative to their four-digit Standard Industrial Classification (SIC) code using the procedures described by Keats and Hitt (1988).

Munificence relates to the scarceness of environment resources that support firm growth in a given industry (Dess & Beard, 1984). This environmental dimension has been discussed within the population ecology literature under the label of environmental carrying capacity (Aldrich, 1979). Munificence is characteristically assumed to have a positive

impact on firm performance and is calculated from changes in an industry's net sales and operating income during the preceding five-year period.

Current results find that munificence is not significant ($p = .28$; one tail) in explaining an acquiring firm's post-acquisition performance. From the perspective of the 1990's defense industry consolidation, this means that post-acquisition per-

"In an environment with fewer competitors, rivalry often plays a coordinating role that imposes competitive discipline on an industry."

formance may be independent of whether an acquiring firm's industry is contracting. From the perspective of 1990's defense industry consolidation, defense firms should have been able to adjust operations to sustain performance in face of DoD spending that in 2001 dollars declined

nearly 18 percent for R&D and 56 percent for procurement between 1987 and 2000 (DoD, 2000).

Dynamism corresponds to uncertainty or the degree of instability and unpredictable change in an industry (Dess & Beard, 1984). Environmental change itself does not imply dynamism, instead dynamism exists when change cannot be anticipated and adequately predicted, creating a situation where integration and coordination are more difficult. Williamson (1975) suggests that under increasing environmental uncertainty higher quality information could be gained by managing transactions internally (i.e., making an acquisition). Current results suggest that industry volatility in and of itself does not impact post-acquisition performance ($p = .42$; one tail). One interpretation of this result is that firms adopt acquisition activity as a tool to

adapt to environmental change that helps firms ensure their continued survival. This is particularly relevant to the defense industry consolidation witnessed during the 1990s.⁵

Complexity relates to the number and diversity of other organizations a firm must interact with (Dess & Beard, 1984). Complexity is reflected in such factors as the breadth and variety of a firm's geographic markets, customers, suppliers, and competitors. In general, fragmented industries are regarded as more complex than concentrated industries (Keats & Hitt, 1988). In an environment with fewer competitors, rivalry often plays a coordinating role that imposes competitive discipline on an industry (Keats & Hitt, 1988). In contrast, market power and resources are relatively widely and evenly distributed among numerous firms in fragmented industries, creating heterogeneous conditions involving intense rivalry. Thus, the dynamics of industry concentration may impact the motivation and resulting performance resulting from absorbing recognized external technological capabilities.

Current results indicate that less complex (i.e., more concentrated industries) lead to higher post-acquisition performance ($p < .05$; one tail). At first glance, this result suggests that continued consolidation of the defense industry may be a mistake in that further consolidation, at this point, would result in two or fewer prime contractors for primary weapon system platforms (e.g., ships, aircraft, tanks, satellites, missiles, etc.). Typically this situation would raise concerns about the ability of industry to retain either enough competition or sustain innovation. However, any monopolistic power in defense firms is compensated by their

facing a monopsony, or market with only having a single customer (e.g., the DoD). Additionally, the government audits the cost of defense contracts and limits the profit defense firms can earn from them.

It is unclear whether continued consolidation in the defense industry and any anti-competitive impacts should be a concern. Still, whether additional consolidation of defense firms occurs or not, rationalization of production capacity should be considered. Despite industry consolidation at the end of the 1990s, every one of the eight military aircraft lines and five military helicopter lines open at the end of the Cold War were still in production (Sapolsky & Gholz, 1999). To a large extent, the facilities responsible for producing 5,195 F-4 Phantom II aircraft (Boeing, 2002) and other Cold War era weapons continue to be maintained. Not even the most optimistic projections predict the same number of models or quantities of future aircraft will be produced due largely to improvements in capability⁶ and increased emphasis on jointness.

TIMING OF ACQUISITION

One possible explanation of an acquiring firm's post-acquisition performance consistent with population ecology (Aldrich, 1979) is that early acquisitions should outperform later acquisitions. An acquisition represents an entry decision for an acquiring firm that may involve "selection" of firms with better resources (Anand & Singh, 1997). Therefore, early acquirers may be able to "select" the best targets and later acquirers have a decreased and less desirable pool of targets to select from. Although the timing of an acquisition has been previously found to be significant (Fowler & Schmidt, 1988),

few studies include time as an explanatory power and only Shelton (1988), in a study of the impact of changing antitrust regulations, attempts to explain time differences in acquisition performance.

Current results suggest that the timing of an acquisition is significant ($p < .10$) in explaining an acquiring firm's performance. Based on one-tail significance tests, acquisitions completed in 1995 ($p < .10$) and 1996 ($p < .05$) performed significantly worse than the 1994 reference category. However, the performance of acquisitions completed in 1997 is not significantly different from acquisitions completed in 1994. The results would appear to show mixed support for early acquisitions outperforming later acquisitions. However, the nature of the cross-sectional regression employed assumes that the underlying pool of firms does not change. There is significant turnover in high-technology industries with firms both entering and exiting the market. The non-significant difference between 1994 and 1997 may have resulted from the ability of acquiring firms to select from a relatively diverse pool of targets in both years. Further studying the impact of acquisition timing on performance represents an opportunity for future research.

"It is unclear whether continued consolidation in the defense industry and any anti-competitive impacts should be a concern."

CONCLUSION

In regard to the first research question, there is clear evidence that firms use acquisitions as a tool to gain access to technology. This finding has implications for acquisitions of U.S. technology firms by

foreign firms. Only national security and not economic security reasons provide grounds for disapproving an acquisition by a foreign firm under the Exxon-Florio foreign acquisition law. It is reported that the DoD is considering cross-Atlantic defense industry consolidation (Urvitz, 1999). Based on the potential technology transfer implications and the demonstrated difficulty in predicting post-acquisition outcomes, encouraging cross-Atlantic defense industry consolidation to realize cost savings may be misguided.

In regard to the second research question, acquisitions, on average, do not improve acquiring firm stock performance. Completed analysis indicates that several

"In regard to defense industry consolidation, results indicate it is not reasonable to expect consolidation will achieve significant benefits in firm stock performance."

factors are correlated with higher post-acquisition stock performance. However, only four of the factors commonly associated with acquisition performance that are under the control of managers appear to impact post-acquisition stock performance. First, the acquisition of target firms in related industries appears to improve post-acquisition performance.

Second, the acquisition of targets that remain smaller than an acquiring firm, but are still of a sufficient size, leads to higher post-acquisition performance. Third, acquiring firms that carry lower debt levels are more likely to experience higher post-acquisition performance. Fourth, acquisitions completed using tender offers lead to higher performance. Combined, these four factors

explain only 12 percent of the observed variance in post-acquisition performance. This is consistent with existing acquisition research that in general explains "less than 10 percent" of the variance in the stock performance of acquiring firms (Sirower, 1997, p. 158). Clearly the dollar value and volume of acquisition activity requires a better understanding of this phenomenon. Therefore, we also considered the impact of external factors on post-acquisition stock performance.

External factors relating to an acquiring firm's industry munificence and timing of an acquisition explain 7.1 percent of the variance in post-acquisition stock performance. Stated differently, 37.2 percent of the explained variance in the current study is due to external factors that are beyond direct control and the majority of variance still remains unexplained after including the most common factors in M&A research in our model. In total, this study only explains 19.1 percent ($F = 2.12$; $p = .015$) of the variance in post-acquisition performance. This means that the majority of variance in post-acquisition stock performance remains unexplained and suggests that government policy aimed at influencing high-technology M&A activity may be misguided since any government intervention may have opposite the desired effect. Additionally, antitrust policies in high-technology industries may be less relevant because the high rate of technology change may keep firms from establishing and exercising monopoly powers.

In regard to defense industry consolidation, results indicate it is not reasonable to expect consolidation will

achieve significant benefits in firm stock performance. Although considerations of defense industry stock performance may be secondary to the governments interests in the short-term, it is of concern in the long-term because it impacts the attractiveness of the industry to employees and investors. The long-term success and health of the defense industry requires attracting the best employees (Defense Science Board, 2000) and maintaining the ability of defense firms to utilize the capital markets. However, a significant portion of high-technology firm employees comes from stock options, and poor performing defense firms would be less able to attract

and retain the best engineers. Considering additional performance measures for the defense industry represents an opportunity for future research.

In closing, the present research reviews current post-acquisition stock performance literature to test factors impacting the post-acquisition stock performance of firms that acquire high-technology targets. Results of the study show that internal and extenal factors do not provide a clear guidance for managers or government policy makers. Additional research, especially focused on the defense industry and its unique market, is needed if factors are to be found that can be used to influence industrial policy.



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APPENDIX: RESEARCH METHODOLOGY

This appendix describes in detail the research methodology used beginning with the sample. The discussion of the sample is followed by a description of the operationalization of all variables and their data sources. Finally, the statistical procedure is summarized.

SAMPLE

The sample used for this study focused on public, high-technology firms that were acquired between January 1, 1994 and December 31, 1997 and had a market capitalization of at least \$10 million. This focus enabled us to isolate acquisitions of a specific type and to avoid studying a cross-section of merger and acquisition (M&A) activity that may introduce extraneous effects. Additionally, the time frame offered control over known impacts of the business cycle on acquisition activity (Ramanujam & Varadarajan, 1989) by ensuring all measurement was limited to a period of favorable economic conditions. A \$10 million market capitalization restriction is consistent with the lower bound observed in previous acquisition research (e.g., Finkelstein, 1997; Ravenscraft & Scherer, 1987) and was intended to ensure target firms were large enough to impact acquiring firm performance.

High-technology target firms were identified as those that (1) were in two-digit Standard Industrial Classification (SIC) code industries commonly recognized as high-technology, and (2) displayed moderate research and development (R&D) intensity prior to being acquired.

Existing literature commonly recognizes seven two-digit industry sectors as high-technology industries: Chemicals [28], Computer Equipment [35], Electronics [36], the aerospace industry [Transportation: 37], Instruments [38], Communications [48], and the software industry [Business Services: 73] (e.g., Certo, Daily, & Dalton, 2001). Moderate R&D intensity was operationally defined as R&D-to-Sales of two percent or greater. This value was based on rounding up from what has been reported as the overall industry average R&D-to-Sales figure of 1.5 percent (e.g., Ravenscraft & Scherer, 1987). This enabled us to conservatively and objectively identify target firms as reasonably R&D intensive without unduly restricting the sample. After applying these screens, a census of 312 high-technology firms was identified.

To identify the final sample, however, two additional restrictions were applied. First, acquisitions were eliminated if the target and acquiring firms' SIC codes were not identified by COMPUSTAT to the four-digit SIC level. This controlled for industry effects and allowed the use of a categorical entropy diversification measure for firm relatedness. It also offered the benefit of controlling for potential confounding effects of conglomerate firms. Second, acquiring firms had to be available in the Center for Research on Security Prices (CRSP) database to allow us to calculate several of our measures (e.g., Jensen's alpha, the premium paid, and relative size). The final sample includes 133 firm pairs.

MEASURES

This section explains the operationalization for each variable beginning with the dependent stock performance variable, and then the explanatory variables in the order they are discussed in the paper.

Firm Performance. Jensen's alpha (Alexander & Francis, 1986), a variation of the two-parameter market model, was used to measure an acquiring firm's performance. For each month after an acquisition ($t = 1$ to 36), the regression model shown in Figure 1 was calculated.

As the regression intercept, Jensen's alpha measures the average difference between the market benchmark's return and the return of the firm (Alexander & Francis, 1986), or abnormal return. If Jensen's alpha is not significantly different from zero, then a firm's stock performance is the same as the market benchmark. Once calculated for each firm, Jensen's alpha is used as the dependent variable in a cross-sectional analysis to test independent variable effects. This application of cross-sectional analysis allows the association between an event

and abnormal returns to be observed (Campbell, Lo, & MacKinlay, 1997). Individual firm stock and market benchmark monthly rates of return were collected from the CRSP database with the S&P500® index serving as the market benchmark.

Diversification. The relatedness of an acquisition was measured as a categorical entropy measure (Hoskisson, Hitt, Johnson, & Moesel, 1993) where relatedness varies based on the degree that target and acquiring firm primary four-digit SIC codes match. An unrelated acquisition (value = 0) is defined as the acquisition of a target firm in a four-digit SIC outside an acquiring firm's two-digit industry group. The first level of related acquisitions occurs when an acquiring and target firms two-digit industry groups match (value = 1). Similarly, when an acquiring and target firms SIC code matches to three- and four-digits relatedness, values of two and three will be assigned respectively.

Relative size. The relative size of firms was calculated similar to Sirower (1997) as the ratio of target firm market

$$R_{it} = \alpha_i + \beta_i (R_{mt}) + \varepsilon_{it}$$

where:

R_{it} is the monthly rate of return of firm i during month t

α_i is Jensen's alpha for firm i

β_i is a firm i 's stock price variance relative to the variance of the market benchmark (m)

R_{mt} is the monthly rate of return of the market benchmark (m) during month t

ε_{it} is the random error term

Figure 1. Regression Model

capitalization divided by acquiring firm market capitalization. Market capitalization was calculated from either the CRSP or Security Data Corporation (SDC) database four weeks prior to an acquisition announcement.

Acquisition Experience. Acquisition experience was operationalized similar to Hayward (2002) with an acquiring firm's acquisition experience recorded as the sum of a firm's acquisitions for the previous three years. Acquisition experience was measured prior high-technology acquisition experience of an acquirer in the three years prior to the acquisition of interest.

Method of Accounting. The method of accounting for an acquisition was measured by using a dichotomous dummy variable (pooling = 0 and purchase = 1). Information on method of accounting was identified from either the SDC database or an online search of business press.

R&D Expenditures. An acquirer's R&D expenditures were measured using R&D intensity (Cohen & Levinthal, 1989, 1990) minus the average R&D intensity of firms in its industry to control for industry effects (Dess, Ireland, & Hitt, 1990). The resulting relative R&D intensity measure was averaged for the prior three years to represent a firm's level of commitment to developing technological capability, while controlling for annual variation. Firm and industry R&D intensity were calculated using data available from *COMPUSTAT*: R&D expenditures (data code 46) divided by sales (data code 12). Industry R&D intensity was calculated from *COMPUSTAT* by calculating the average R&D intensity for all firms with the same four-digit SIC code.

Acquiring Firm Debt. The level of an acquiring firm's debt was measured

using the current ratio. It was calculated by dividing a firm's current assets by its current liabilities with data from *COMPUSTAT* — data codes 4 and 5 respectively.

Form of Acquisition. The form of acquisition, merger or tender offer, was measured using a dichotomous dummy variable (merger = 0 and tender offer = 1). Information on the form of an acquisition was identified from either the SDC database or an online search of popular business press.

Target Firm Performance. The industry adjusted profitability of a target firm was measured by calculating a target firm's Return-on-Sales (ROS) in the year prior to its being acquired. Profitability was measured using ROS for each firm the year prior to an acquisition, and was obtained from *COMPUSTAT*: net income (data code 172) divided by sales (data code 12).

Firm Environment. A firm's environment was measured using the three environmental dimensions of munificence, dynamism, and concentration computed at the four-digit SIC level using the procedure described by Keats and Hitt (1988) and calculated for the five preceding years, beginning in the year prior to acquisition. Succinctly, munificence is the average of the regression coefficients of a four-digit industry's net sales and operating income over the preceding five-year period. Dynamism is the average of the standard errors of the regression slopes for the two munificence regression equations. Complexity is a market concentration measure computed by regressing the terminal-year (i.e., year five) market shares of the firms in a given industry on these firms' initial-year

(i.e., year one) market shares. Note: lower values on the complexity scale signify *higher* levels of complexity.

Timing of Acquisition. The year, or time impact, of an acquisition was measured

using a polychotomous dummy variable (1995 = 1, 1996 = 2, and 1997 = 3) with the year 1994 serving as the reference category.

ANALYSIS

Analysis of Variance (ANOVA) was used to identify the significance and individual level of variance explained by independent variables (Bray & Maxwell, 1985). Supplemental analysis was used to determine if the assumptions (the same as regression) of analytical technique were met. Graphs of error terms were consistent with conclusions that they are normally distributed. Further, none of the variable bivariate correlations exceeded .5, indicating that multicollinearity should not be a concern (Gujarati, 1995, p. 335). The data from independent firms over different time periods were combined in a cross-sectional analysis, and would not

be expected to exhibit autocorrelation commonly associated with time series data (see Griffiths, Hill, & Judge, 1993). However, the cross-sectional analysis of data over several years and the significant difference between the year an acquisition was made may indicate a violation of the constant variance assumption (see Griffiths, Hall, & Judge, 1993). Supplementary analysis using the Goldfeld-Quandt F-test showed none of the year-year and full model combinations are significant. This suggests that variance across the different years is homoskedastic, or displays constant variance.

ENDNOTES

1. Please see the Appendix for a description of the study's methodology.
2. The authors were unable to confirm that Tinsley was ever divested from ASM Lithography.
3. The potential implication is that existing M&A research may be biased by model under-specification (see Griffiths, Hill, & Judge, 1993: 312).
4. The Financial Accounting Standards Board eliminated pooling of interests accounting and modified recording of goodwill with purchase accounting for all acquisitions completed after July 1, 2001.
5. We would like to thank Steven L. Schooner of George Washington University Law School for making this observation.
6. A single F-117 mission can accomplish today what 95 sorties achieved during Vietnam or what 4,500 B-17 bombers achieved during WWII (Toffler & Toffler, 1993).

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DISTRIBUTION

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